

## DEVELOPMENTS IN FLAX SPINNING.

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AMONG the numerous arts and crafts which came into being when the world was young, and which furnish so many of the picturesque details of the life of our ancestors, spinning assuredly was one of the earliest invented, and became one of the most universally followed. Of all the various textiles which have been used by mankind, I doubt if one can compare with flax, either in point of antiquity or in universality of employment.

The limits of this paper do not permit of my discussing the very early methods of flax spinning. There is to be seen, however, in our Municipal Museum a very fine and complete collection of spinning wheels which belong to the hand-spinning period, and which we owe to the diligence and the liberality of our townsman, Mr. John Horner. The majority of these spinning wheels were used for flax, and come from nearly every part of the world. They carry us back to the time when the distaff or the spinning wheel were to be found in almost every house, and her store of linen was the pride of each housewife and a testimony to the skill and industry of herself and her daughters.

About the end of the 18th century cotton began to be spun mechanically, and the venerable and wholly admirable craft of flax spinning as a consequence was fast disappearing, and flax as a textile was in danger of going out of use entirely, when the principle underlying the spinning of flax by machinery was discovered in the early years of the 19th century by Philippe de Girard, who thus saved the industry. This principle is based on the particular construction of the flax plant, which supplies the fibre in quite a different way from the cotton plant, though chemically both fibres are practically identical.

Cotton is got from the seed bolls of the cotton plant, and is a collection of smooth, homogeneous indivisible fibres separate from each other, drawing past each other readily, and pliable and elastic enough to withstand easily the shocks and strains inseparable from the preparing and spinning processes.

Flax, on the other hand, is stiff and inelastic. It is the fibrous bark of the flax plant, and even when this fibrous covering of each stalk is removed by retting and scutching from the woody part of the plant, and split up by hackling into what look like single fibres, these are really composed of a large number of small fibres glued together by a substance called pectose. It is difficult to separate the ultimate fibres of flax, which are about  $1\frac{1}{2}$  in. long and terminate in an extremely fine tapering point. Hackling and preparing only tear them apart and break them, whereas in wet spinning the hot water in the trough macerates the pectose sufficiently to allow the

ultimate fibres to slide past each other as they are drawn between the drawing rollers. When dried the yarn becomes the stiff and inelastic thread that we all know.

It is the nature of the treatment in wet spinning that makes it possible to spin fine linen yarns mechanically; dry spinning or damp spinning is only possible for coarse numbers. Someone may say that in the hand spinning of very fine numbers, such as is still done to a small extent in the North of France, there is no equivalent to the maceration of wet spinning. The explanation is that in the first place none but the very finest flax is used for hand spinning, being picked straw by straw; and then it is hackled almost to destruction, only about 10 per cent of yield of line being obtained. Of the fine fibres thus remaining, no more than two or three deliberately selected by the spinner go at one time into the yarn, the moisture required to bind them together being supplied by the spinner at short intervals touching her lips with her finger tips.

The discovery or invention, then, of de Girard laid the foundation of the flax spinning industry, which rapidly developed into one of the important textile industries of the manufacturing world. I do not, however, propose here to go once more over oft-trodden ground and give figures showing how the number of spindles grew rapidly to be followed by a period of stagnation and decline. I intend rather to describe some of the changes which, owing mainly to the stress of competition, have taken place in the machinery and arrangements of a flax spinning mill and indicate the present tendency.

It has often been remarked that flax spinning has not changed, that it is now where it was 50 years ago. But if some of those who make such statements could now see a mill of that period they would be amazed at the change in almost every department. There have been no radical changes, but a slow, gradual change amounting almost to a transformation, or else it could not have survived the competition of cotton. This competition has always been one of the dominating influences in the flax spinning trade, and it will be well thus early to point out some of the reasons why the finished products of flax are so much higher in price than those of cotton, though the first cost of the raw material is not so very different.

There is, first of all, the process of hackling, which splits up the raw fibre, the short lengths being removed as tow; this being of a comparatively small value, the cost of the remaining portion or "line" is proportionately raised. Then there is the great diversity of the crop as it grows. When any particular lot of flax, grown in the same field and handled all through as one lot, is sorted after hackling there will frequently be six "sorts" or qualities found in it, the highest being nearly twice as valuable as the lowest. For all but the commonest flax this state of affairs necessitates the expensive process of sorting. These two processes of hackling and sorting make the dressed line, roughly, twice as expensive as the raw flax.

During the preparation, including spreading, drawing, and roving, the tendency of the flax to "lick up," or follow round on the roller over which it has just passed, is a serious factor, necessitating, among other things, very close supervision and working with a flat heavily-pressed sliver, with special and more expensive design of machinery than is suitable for cotton, and limiting very much the use of automatic stop motions and other labour-saving devices. Again, the length of the fibre and the method necessary to split it up and maintain it parallel while drawing it out involve the use of the very expensive gills in spread-boards, drawing and roving frames.

Lastly, there is the comparative inelasticity of flax, which, together with the weight of the wet thread in spinning and the "glit" or gummy matter which it throws off while receiving the twist, prevents the use of ring spinning, with its high speed and consequent cheap production.

These disadvantages inherent in flax as a textile in comparison with cotton may be expressed in a different way, and one which will appeal more readily to those familiar with the cost of building and running a mill.

A flax spinning mill would cost from £5 to £8 per spindle, according to fineness, to put down, whereas a cotton mill would cost from 27s. 6d. to 30s. per spindle. A high cost increases the charges for wear and tear and requires a larger margin of profit per bundle of yarn (assuming equal production) to give an equal return on the capital invested. But, further, the very much larger number of hands employed, in spite of their somewhat lower wages, results in the spinning cost of a flax yarn being four to five times as high as that of a cotton yarn of the same count.

The initial disability thus borne by linen yarn goes a long way to account for the continual inroads made by cotton on the domain over which originally linen reigned supreme. The inherent beauty, excellence, and hygienic properties of linen have not been sufficient in the eyes of the majority of the buying public to compensate for its greater first cost as compared with cotton.

This brings me to the main theme of my paper, namely, the developments which have taken place in the equipment of a flax spinning mill to enable its products to arrest and, as I believe they yet will do, beat back the invasion of cotton.

One of the points at which improvements began was the hackling machine. It is here the first great increase in the cost of linen yarn begins, by the conversion of so large a proportion of it into comparatively low-priced tow. Through the primitive inclined sheet machine of Combe, the improvements went on to Lowry's, Horner's, and Cotton's machines in Belfast and Dossche's on the Continent.

The operation of machine hackling consists in screwing handfuls of flax, or "pieces" as they are termed, into holders introduced into a channel which lowers one end of the piece between a pair of revolving sheets clothed with pins, and after

a proper interval raises it again out of contact with the pins. It is then moved forward in the machine and submitted to a similar operation by pins placed closer together, and so on, over a whole range of sets of pins, termed "tools," as fine as is appropriate to the quality of flax being worked or the purpose it is intended for. After going through one machine the pieces are reversed and similar work is performed on the other end of the flax in a second machine.

An early advance made was by lengthening the machine and using one row of pins in each gill stock instead of two, and also graduating the pins better. The effect obtained was a leveller cut and an increased yield of line, while the attention given to the doffing of the tow has improved the condition of that by-product, if it can be so called. This was a very expensive step in advance, the new machines costing more than twice as much and occupying almost three times the room of the earlier machines, so necessitating in most cases the rebuilding of the room assigned to them.

A further important step was made when automatic attachments were introduced enabling one boy to attend with ease to a pair of machines, which hitherto had been heavy work for four boys, so effecting a saving in wages in this operation of close on 75 per cent and appreciably improving the yield of line. This is the result of the holders being screwed mechanically, all to the same desired tightness, independently of the boy being fresh or tired. Moreover, the adoption of the automatic screwing attachments involved practically no structural alterations to existing machines.

Now a further improvement is in sight, rendered possible by the use of the automatic screwing apparatus, namely, the automatic delivery of this hackled flax on to the sheet of a spreadboard. This, however, is only possible where flax is intended to be used without sorting.

The next department in a mill after the hackling and sorting is the preparing, consisting of spreading, drawing, and roving for line and carding, drawing and roving for tow, with combing added after the carding for certain classes of tow. In spreading the "pieces" of flax are sub-divided by hand and spread on the feed-leathers of a spreadboard, each small piece being laid overlapping the preceding one. The six or eight slivers of the spreadboard, issuing out as one and being measured into a can in lengths of 500 or 1,000 yards, form the point of departure for determining the ultimate lea of the yarn by means of the doublings and drafts in drawing, roving, and spinning.

In appearance the preparing department has changed little during 50 years, for in many mills frames could be found of that age working alongside modern ones, which differ little from them except in detail; this does not, however, imply stagnation. Within the last few years heavy spreadboards have been introduced, chiefly for coarse numbers, on which a whole piece as it comes from the hackling machine or sorter is spread, and usually in this case the old spreadboard has been retained as an extra doubler. This

spreadboard deals with as much material as five or six of the smaller boards, and so considerably reduces the cost of spreading.

In the early days it was customary to work with but three drawing frames between the spreadboard and roving frame, while now four are everywhere the rule. This change has had for effect the production of a leveller yarn with the same material or an equal yarn with somewhat poorer material. While this change was going on, another, carrying the same result still further, was also taking place, which was much more costly as regards capital charges and wages, and it is still going on. That is the increasing of the amount of preparing relative to spinning machinery, usually expressed in terms of spinning spindles to roving spindles. The proportion varies according to the type of yarn spun, but one might say in a general way that the preparing has been doubled; where a mill many years ago had 7.5 spinning spindles to each roving spindle, it now may have somewhat less than 4.0. In this, as in many other points, flax spinners have not shrunk from very largely increasing the amount of capital sunk in their mills so as to produce a better or a cheaper yarn.

The changes in the preparing machinery itself have not been great; improvements have been effected in details, which all go to make it more perfect. Probably the most valuable has been the improvement in the drive of the bobbins of the roving frame, carried out in different ways by different makers, but arriving at the same desired end, the perfectly even and smooth laying of the layers of rove on to the bobbin. Another has been the traversing of the front roller, so as to equalise the wear on its surface. Again, some spinners have found considerable advantage in lengthening their drawing frames, with each head driven independently and stopped by a stop motion or failure of a sliver. These machines are made by Walker, of Lille.

In tow preparing the changes have been more marked, specially in the direction of lighter carding, the most recent arrangements for fairly heavy numbers resulting in approximately one card per spinning frame. The increased number of workers necessitated thereby has fortunately been counterbalanced by the introduction of automatic card feeds, at first mainly Tatham's, which were improved from time to time, and at the present time a German make, Liebscher's, is much in favour.

There are no flats used in carding flax tow, the cylinders are generally either 5 ft. or 4 ft. in diameter, and are surrounded by worker and stripper rollers, finishing up with one or two doffers. The majority of cards are now furnished with drawing heads, which do the work of a drawing frame, effecting a preliminary parallelisation and consolidation of the sliver.

Combing machines are another innovation, or rather revival, for many years ago considerable numbers of such machines were made by Lawson, of Leeds, but owing to their small production and the excessive amount of attention they required, these gradually went out of use in every mill but one. Then, as I said,

they were revived on the introduction of an improved machine on the same principle, Heilmann's, made by Schlumberger. This machine has proved very successful, and has resulted in the production in large quantities of good, level, if somewhat soft, yarn from material which, owing to it being so nappy, had a comparatively small value. Latterly another comb, still on the same principle, made by Delette, has found considerable favour.

Some of our friends who are interested in wool or silk may wonder why no other comb than Heilmann's is used. Extensive trials were made by one firm some years ago with Noble combs, but without success. One difficulty was balling the silver to feed the machine, or rather unwinding these balls when made. But the chief and fatal objection was the difficulty of cleaning the combs from the accumulation of dust and shives which ultimately broke down whole sections, more especially of the finer rows in both the larger and smaller combs. I am not aware of the Lister comb ever having been tried for flax.

The latest development in tow preparing is the introduction of double-threaded screws, allowing a higher faller speed and shorter drafts, which are the feature of tow preparing in connection with light carding.

We now come to the spinning, which is the department where least change has taken place, though it is probably at this point that most attempts have been made to overcome the limitations of flax as a textile or follow the developments of cotton or worsted spinning.

In a wet spinning frame, the rove after leaving the creel passes through a hot water trough of a temperature of approximately 120 deg. Fah.; thence it passes between two pairs of fluted rollers with a draft varying according to the weight of rove and lea of yarn required. The top or retaining roller, which is of brass, has a pressing roller of brass, and the bottom roller, also of brass, has a pressing roller of boxwood. From the bottom roller the yarn passes over a threadplate to a flyer eye, which twists it and winds it on to a bobbin. The bobbins are usually made of teak for the coarse and mahogany for the finer. The rove, in issuing from the trough, is saturated with water, and, in addition, warp yarns frequently have an extra water drop on to the top roller to help to keep the yarns clean. When on leaving the bottom roller the twist begins to be put into the yarn, and then again when passing the thread plate, and finally when going over the curl or twizzle of the flyer, a fine spray is thrown off, and with this spray a certain amount of soluble matter out of the fibre and also solids which were there as dust. In spinning a fine yarn, this spray is barely perceptible to the hand, but in the case of a coarse yarn a large amount of water is thrown off, which would speedily wet the spinner through were she not protected by a waterproof apron and the splashboards of the spinning frame. The various substances carried off by the water form what is known as glit wherever it falls. Very quickly threadplate, flyer, builder, and other parts

of the frame and the floor of the room get coated with this "glit," and it is necessary frequently to wipe down the machinery and wash the floor.

The spinning frame has remained practically unchanged from the first. It is a simple looking machine, but there are many seemingly trifling points about it which are nevertheless of the utmost importance. In the design of the frame there are the size and flute of the rollers, the spindle and bobbin, the "lines" of the frame—that is, the relative position of rollers, threadplate, and flyer eye, etc.—while in the working of the frame the condition of the flutes on the rollers, especially those of the boxwood pressing roller, and of the flyer eyes, as well as many other things, demand constant attention. With all this the properties of the fibre prevent anything more than a very moderate speed, with frequent doffing, and consequent high cost for the actual spinning.

And yet here, too, we find progress. The earliest built mills, of which a few examples are still extant, measure no more than 37 ft. or 38 ft. inside, with the columns in the middle, giving a shorter frame on one side of the room than the other, so as to allow for the pass. It was soon realised that the frame on each side of the room should be of the same length, and so in subsequent mill buildings the columns were placed to one side so as to allow of a central pass and equal frames on each side. Then as better and more ample preparing allowed of a girl minding more spindles, the width was gradually extended, a usual width being 48 ft. to 50 ft. inside. Now we find that in the most recent mill buildings the inside width has exceeded 60 ft., and even in a mill in course of erection 67 ft. has been adopted, so that where in the oldest mills a girl attended as few as 124 spindles of, say,  $2\frac{1}{2}$  in. pitch, frames are now being made with the intention that a girl shall mind 260 spindles of that pitch. To help to secure this end, rove bobbins are being increased in size, so as not to run out so quickly.

Except for the increase in length above referred to, the only improvement that may be said to have been established is the spinning of fine weft in the shape of pirns on to a small paper shell ready to be placed in the shuttle. Owing to the small diameter it was found possible to dry these satisfactorily, but the difficulty of drying was one of the stumbling blocks in trying to adopt the same principle for coarser yarns.

Almost innumerable have been the experiments made to improve the spinning process, many of them with high hopes of success only to doom the inventors to disappointment when tested on a commercial scale.

Repeated trials have been made of ring spinning, and the rigid nature of linen yarn making the usual form of traveller unsuitable, others were designed to compensate for that defect in the yarn. But the difficulty that was mainly responsible for the failure of all these was the damp and dirt, rusting and clogging the rings and travellers, not to mention the impossibility of "laying on" an end as it is found desirable with the better yarns.

Swing rails were tried to obtain more regular tension on the bands that drive the spindles, and so secure more regular twist. Cap spinning was tried and spinning with an inverted flyer, spinning on the bare spindle, rabbeth spindles, driven rings, and many other things, but the spindle and flyer remain.

Again a promising attempt was made, by introducing a certain chemical solution into the trough, to make the flax more easily drawn and make possible a superior yarn from poor material. But difficulty was experienced in securing uniform results in the yarns, and frequent breakages and other trouble with the machinery occurred, and this attempt also came to nothing.

Wet spinning, however, is not the only form of spinning used. For coarse numbers and for certain purposes dry spinning has its advantages. In this the sub-division and drafting of the fibres is merely carried a stage further than in preparing. The length of reach is but slightly reduced as compared with that of the roving frame, no drawing of the ultimate fibres past each other takes place. These yarns, though restricted to the coarse numbers, produce a cloth with more lustre than if made from wet spun yarns, the maceration of the latter in the troughs destroying evidently in part the natural beauty of the fibre.

Intermediate between the two, but allied in principle to dry spinning, is damp spinning, used mainly for shoe threads. The thread during twisting is in contact with a damp flannel-covered roller, so as to lay the hairy projecting ends of the fibres. Allied to damp and dry spinning there is also gill spinning. The frame is more of the nature of a roving frame, having gills between the rollers to hold the fibres during drafting, and a yarn twist is given instead of the slack roving twist.

In former times practically all yarns were reeled and dried and bundled, but since the adoption of pirn spinning, in which the yarns are not reeled but sold as pirns, there has been a tendency to deliver yarns in various shapes more convenient for the subsequent user, and large quantities are now sent out cross-wound or on cops. Many yarns are twisted for various weaving purposes either 2 or 3 fold, while the proportion absorbed in the making of thread, specially shoe-threads, has been slowly but steadily increasing.

This concludes my remarks as to the mechanical manufacturing equipment of a mill, but I cannot leave the subject of machinery without paying a tribute to the excellence which has always characterised it. Headed by the Combe Barbour branch of Fairbairn Lawson Combe Barbour Ltd., the senior firm, and James Mackie and Sons Ltd., with those incidentally mentioned above and a few others, the makers of flax spinning machinery can fairly claim to turn it out as well fitted as any made for other industries.

There have been other changes in a flax spinning mill than those in its machinery, which in their way are no less striking. I refer to the amelioration of the conditions of work through ventilation, dust extraction, steam-pipe covering, etc.

This began with the somewhat indiscriminate placing of exhaust fans in windows, but about 18 years ago an immense step forward was taken in roughing and sorting shop ventilation by localising the exhaust, collecting the dust as near as possible to where it was produced, and so preventing it from becoming diffused throughout the room. The transformation thereby effected was far beyond expectation, and now we could scarcely call to mind the conditions as they formerly existed. The Home Office soon took up the lead given by certain of the spinners, and made this localised exhaust compulsory in the hackling department of all mills. It ultimately was extended to the preparing department with equally beneficial results, not merely to the health of the workers, but also to the class of work turned out. In the spinning rooms the use of splashboards has been extended in face of much opposition from the workers themselves, and so the amount of water reaching the worker or getting on to the floor has been considerably diminished. At the same time attention to the design and condition of trough lids has prevented the escape of steam into the rooms, and the covering of steam pipes and the introduction of exhaust ventilation has reduced very materially the heat of the rooms.

There is no doubt that up to 20 years ago conditions of work in the flax spinning industry left much to be desired. Possibly they were little if any worse than in cognate trades in England, but in any case there has been a very great improvement, and I doubt if a competent and impartial investigation could detect any appreciable difference in the health of flax spinning mill workers and that of the general public. The gradual reduction of working hours has doubtless contributed to this condition of things, and now that most Continental nations are gradually approximating to our legal working hours, I look to a still further gradual reduction, which, I believe, will be for the benefit of the worker and not inimical to the interests of employers.

A question I have not so far touched upon is the more general one of the drive. The prime movers employed have not fallen behind those in use in other industries. There have been beam engines (some still working), horizontal and vertical compound and triple-expansion engines, and latterly turbines. The method of applying the power was first of all through gearing, and then many drives were altered to ropes, and latterly a few to the electric driving of main shafts, or group driving.

The excessive damp previously the rule in the wet spinning rooms and the smallness of the units in the others long prevented any application, even experimental, of individual electric drive, but latterly this has been made possible not only by the improvement in spinning room conditions, but also in the motors themselves. In several instances the individual drive has been adopted with encouraging results.

I have now indicated the main developments which have taken place. What of the future? Is this industry going to maintain a precarious existence? Is it going to disappear finally, or is it going

to take a new development? Can we hope that in the matter of cheap production it will ever be a serious rival of cotton? I am inclined to be optimistic.

During the years when the price of cotton was so low, flax fell in value too, probably to some extent owing to the same causes, but partly, no doubt, also forced down by cotton. It fell to such a price that farmers gave up growing it, and a few years more of such values would have killed the industry through lack of raw material. In most countries the acreage under flax was much reduced, and last winter, owing to a small yield in 1910, crop values were forced up to a level unheard of since the American war. Happily for us cotton could not be grown at the prices once ruling, and it too went up, and remained up for longer than most persons expected. The question now is, how long will this advance be maintained? In the case of cotton, it is clear that if the world's requirements increase faster than it is found possible to increase the acreage, prices will rise still further. That eventuality is not at all impossible, and therein lies the main chance for any considerable extension of the flax spinning industry. I do not foresee any prospect of materially cheapening either the production of flax or the process of converting it into yarn. But of one thing I feel sure, and that is that however severe a struggle the future may have in store for them, the spinners of the North of Ireland will face it with the same courage, energy, resolution, and skill as have enabled them to emerge successfully from many a severe struggle in the past.

#### DISCUSSION ON FLAX SPINNING.

MR. BLEAKLEY (Manchester), opening the discussion, observed: I know extremely little about flax, but I wish to suggest a little continuity in the papers of to-day by indicating a possible answer to questions asked by Mr. Crawford. It appears to me that there is no lack of ingenuity or suitability in the machinery, but is it a fact owing to the way in which the flax fibre is treated it is possibly improvable? The trouble, I understand, is inefficient hackling. It appears in the paper that in the process of hackling the glit is not efficiently removed. Now the only point of my interposition here is that in the paper on Ramie there is a suggestion of the possible improvement in this preliminary treatment. The author of the paper will not be here. When it was decided to settle this question of giving a paper on Ramie, two editors of textile papers (Mr. E. E. Marsden and Mr. Nasmith) were asked who was the best authority, and they each selected Mr. Barraclough. He has had much experience in the treatment of Ramie, which, I suppose, is akin to flax. If he says what is correct, he has succeeded in getting rid of a good deal of this glit.

I believe that when you hear his paper on Ramie you will find that there is some attempt to answer this question, and if it is possible to improve the preliminary preparation of flax, other processes would be consequently better able to perform their task. However, I wish to thank Mr. Crawford for his admirable paper.

MR. CARTER (Belfast): Mr. Crawford says that chemicals in a trough had proved a failure, but it was questionable whether that process was yet dead—probably some people still use spinning frame chemicals in a slightly different way. I believe that flax spinners have come to the conclusion with machinists that the Rabbeth spindle is a failure as regards flax spinning. However, when I was in Lille a few months ago I was talking to Mr. Sam Walker, the largest flax machine maker on the Continent, and he was optimistic about the Rabbeth spindle, and was putting more in. Of course, he was applying a new brake, which would probably get over the difficulty caused by vibration in stopping the spindles.

MR. R. GARRETT CAMPBELL (President of the Flax Spinners' Association) said: The question raised by Mr. Crawford as to the future of linen in competition with cotton is, of course, one of immense interest to Belfast. He has indicated the difficulties that had to be dealt with in the manufacture of flax—a fibre which cost no more than cotton fibre as a raw material, but which when delivered to the consumer as linen fabric cost immensely more than cotton fabric. Mr. Crawford has pointed out that the main causes of that were first, the length; secondly, the inelasticity of flax fibre. These qualities entailed immense extra cost in machinery and in working. When flax fibre was reduced to its ultimate length of about  $1\frac{1}{2}$  in., we have a fibre of extreme beauty, but the cost of doing this is very heavy and the loss in weight very great. Then there is the immense difficulty of dealing with the fibre. The matter of Ramie fibre has been mentioned. I have hardly passed a year in my business life without having had parcels of this fibre prepared in all kinds of ways to test in working. The attempts have not been successful. It could not be worked in our flax machinery; it would not hold together, and seemed to have no faculty of forming a sliver. With regard to flax fibre, its character and nature seem to place us between two horns of a dilemma—either we must continue to work it in its present imperfect way or we must remove the pectose entirely and get a fibre which our machinery would not work. I would not like to say that some of the difficulties might not be removed or lessened, but I think enough would still remain to make linen fabrics very much dearer than cotton fabrics, and those engaged in flax manufacture must rather rely upon the superior beauty and quality of their fabric than upon approximating its cost to that of cotton.

MR. HEYLIN (Manchester) wanted to know whether a standard of moisture in linen had been arrived at. He also strongly advocated shortening of the working hours in mills.

MR. S. K. FERRIER (London) said he was specially interested in the part of the paper dealing with electric driving. He stated that electric driving is very largely used in mills on the Continent, but that in this country progress in this direction had been, comparatively speaking, slow.

MR. JOHN HORNER (Belfast): I think we ought to congratulate Mr. Crawford on his paper. It has been often said that I belong to the antique side of the flax spinning industry. I think it will be found that Phillip de Gerard was not the inventor of wet spinning or maceration; the inventor was undoubtedly Kay, of Preston, in 1825. Phillip de Gerard at that time claimed priority and cited an invention of his dated 1814, but in the specification there was no attempt at maceration described, but simply the bringing of the fibre over a damping roller before the roving and drawing, which meant simply bringing the fibres together. This was substituted by the hot water troughs, which enable maceration whilst the thread is going through the machine. I was very much interested in Mr. Campbell's remarks about taking away this pectic matter which holds the fibres together. When cotton spinning came into existence owing to the inventions of Arkwright, Hargreaves, and Crompton, it was found impossible to spin flax on the same machinery on account of the long length of the fibres. A Frenchman invented a chemical process, by which the pectic matter was ultimately released. Now it seems an absurd thing to turn good flax into poor cotton; it was really what they were doing. This pectic matter is the strength of the flax; the maceration does not destroy it, but simply loosens it. A quantity of flax was depectinised during the Cotton Panic and sent over to John Bright's mill in Rochdale and worked up there. I would like to congratulate Mr. Crawford on his statement with regard to shorter hours of labour; I think it comes excellently from him, and it is a courageous statement for a large employer of labour to make.

MR. GEORGE GARNETT (Bradford) said: I should like to express my appreciation of the value of the paper. The one point that interested me was that of machinery. I should like to know if the improvements have come from the initiation of manufacturers or machinists. In many industries I believe the lead has been taken by machinists. Unless there is a close co-operation between the two, the industry would not prosper as it ought. In the woollen industry many of the improvements had been brought about by machinists. New machinery is constantly coming into the market and old machinery is constantly being "scrapped" in order to keep the woollen and worsted industry up to date. A new machine has been brought out by Platt Bros. and Co. Ltd., Oldham,

introducing the principle of continuous spinning, and I think this, with its cheaper and quicker production, will be a serious competitor of the mule before very long. I am surprised, however, to hear Mr. Crawford say that the higher prices of cotton will enable the linen trade to prosper. My opinion is that high prices are not conducive to successful trading. In England we must look for lower prices as being one of the factors that speak well of regular trade for everybody. But how is it that the flax industry is centred in the North of Ireland? No doubt the question could be readily answered. We have practically lost it in England with the exception of a little weaving around Barnsley. We must not lose sight of the importance that workpeople play in the production of textile goods, and it is a pleasing fact that excessive hours of labour have been curtailed. I am one who believes in making the conditions of work as excellent as possible, because if you get tired workpeople you get work indifferently done; whilst if surroundings of work are made convenient and comfortable one is then doing his best for the trade as a whole. (Applause.) In Bradford we are anxious to establish standards, and unless the Institute speaks out on that matter, I am afraid that there will be some disappointment. I think standards ought to be fixed in all branches, as it would make it better for carrying on the trade more honestly.

MR. CRAWFORD, being asked to reply to the discussion, said: I must thank you very heartily for the kind reception you have given me. I entirely agree with what Mr. Campbell has said about the treatment of flax, and I can assure him he is not the only one who has received samples of Ramie in all stages of preparation. I think these samples went round. As to the establishment of standards, I might remark that a good many years ago there was a congress at Turin, at which the standard moisture for flax was fixed at 12 per cent regain. Two years ago an international federation of flax spinners was formed, and one of the first subjects taken up by the new organisation was the standard of moisture permissible. The 12 per cent standard was recognised, and the council of the International Federation of Flax Spinners' Associations are taking steps to enforce that standard in their model contract for the purchase of flax. In this matter they are working in harmony with the Russian Government, so that when a basis is arrived at I hope it will be recognised all over the world. As to the introduction of colours into linen, Mr. Crawford said this did not strictly come within his province, but anyone who has worked with flax and endeavoured to dye it will realise that it is an incomparably more difficult fibre to dye than either cotton or wool. But in matters of this kind much useful work may be found for young members of the Institute. Several of the speakers have referred to the reduction of working hours. Where the workers are paid by time a reduction of hours will also entail a reduction in production, although the reduction in production would not always be in the same proportion as the reduction of hours. While the working

hours in this country were very much less than those in Continental mills, employers would have felt it a great hardship to make a further reduction, but now that the conditions approximate more closely than before, they could view a reduction with less misgiving than would have been the case a few years ago. In regard to improvements in machinery, I should say they have been due equally to machine makers and spinners, and on the whole I do not think that in the textile trade there is any branch better off in this respect than the flax industry. Reference has been made to the high price of cotton favouring the sale of flax; of course, that would be favouring it relatively. It is quite possible that values of all manufactured articles will tend to gradually rise, but it is also conceivable that one particular commodity will rise more rapidly than another, so that others will be favoured, relatively speaking. As to the reason for the flax industry being largely centred in the North of Ireland, no doubt the atmospheric conditions of the district have something to do with this, and there is also the fact that no other textile industry is located here. Then, again, the cost of living is low, and wages being consequently somewhat lower, there is a natural tendency for such an industry as that of flax spinning to gravitate to this part of the country. No doubt the industry has also been helped by the presence of the shipyards, which have given employment to the men, while regular employment has been found in the mills for the women and girls of the family. With regard to electric driving, we in Ireland are not neglected by makers of electric machinery, as we receive their visits very regularly. And I do not think there is any fear of us being left in Egyptian darkness in that matter.